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Japanese (PDF)

File Wrapper Information

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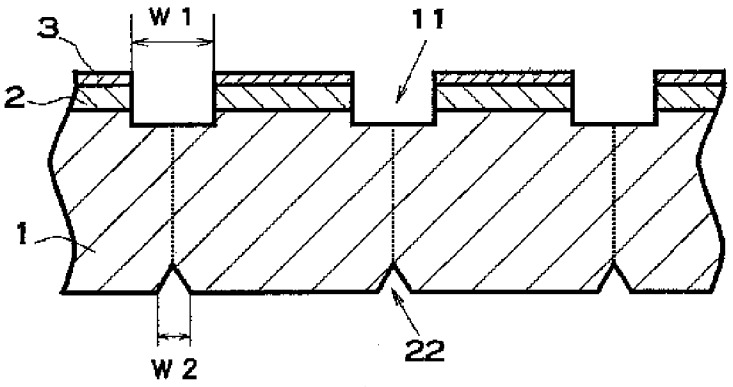
FULL CONTENTS

[Claim(s)]

[Claim 1] In the method of manufacturing a gallium nitride system compound semiconductor chip from the wafer which laminated the gallium nitride system compound semiconductor on the sapphire board While forming the first rate slot in a line in desired chip form from the gallium nitride system compound semiconductor layer side of said wafer [ this first rate slot / in the process which penetrates a gallium nitride system compound semiconductor layer, and is formed to the depth except a part of sapphire board, and the position which agrees with the line of the first rate slot from the sapphire board side of said wafer ] The production method of the nitriding Gary Lim system compound semiconductor chip characterized by providing the process which forms the second rate slot which has line width (W2) thinner than the line width (W1) of the first rate slot, and the process which separates said wafer in the shape of a chip along said first rate slot and said second rate slot.

Drawing selection Representative draw

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[Claim 2] The production method of the gallium nitride system compound semiconductor chip according to claim 1 characterized by forming said first rate slot by etching.
[Claim 3] The production method of the gallium nitride system compound semiconductor chip according to claim 1 or 2 characterized by forming said second rate slot by Sklar Eve.

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[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the production method of the gallium nitride system compound semiconductor chip used for luminescence devices, such as blue, green or a red light emitting diode, and a laser diode. It is related with the method of cutting the nitriding thing semiconductor wafer with which the gallium nitride system compound semiconductor (it is hereafter indicated as a nitriding thing semiconductor.) especially expressed with general formula InXAlYGa1-X-YN (0<=X<1, 0<=Y<1) on a sapphire board was laminated in the shape of a chip.
[0002]
[Description of the Prior Art] Generally the semiconductor chip which is a source of luminescence is prepared on the stem at luminescence devices, such as a light emitting diode and a laser diode. As a material which constitutes a semiconductor chip, in the case of red, orange, yellow, and a green diode, GaAs, GaAlAs, GaP, etc. are known, for example, and if it is a blue diode, ZnSe, InAlGaN, SiC, etc. are known.
[0003] Generally DAISA or a scriber is conventionally used for the equipment cut down for the chip for luminescence devices from the wafer with which the semiconducting material was laminated. After DAISA carries out the direct full cut of the wafer or cuts the slot of width larger than edge-of-a-blade width deeply in rotational movement of the blade which is generally also called a dicing saw and uses the edge of a blade as a diamond (half cut), it is equipment which breaks a wafer by external force. the both-way straight-line motion of the needle which uses a tip as a diamond as well as a scriber on the other hand -- a SUKURA eve line (marking line) very thin to a wafer -- for example, after pulling in a grid pattern, it is equipment which breaks a wafer by external force.
[0004] For example, since there is ****** in the <110> directions to the crystal of zinc structure which does not carry GaP, GaAs, etc., it can fracture in the shape of a chip easily by putting in a SUKURA eve line in this direction with a scriber using this character.

[0005] However, generally, since a nitriding thing semiconductor was laminated on a sapphire board, it was difficult for the wafer not to have ****** to up to the character of a sapphire crystal called a hexagonal system, but to cut with a scriber. On the other hand, when cutting by DAISA, [ a nitriding thing semiconductor wafer ] it is said what is called hetero epitaxial structure that laminated the nitriding thing semiconductor on sapphire as carried out -- grating constant irregular ** -- it was large, and since coefficients of thermal expansion also differed, there was a problem that a nitriding thing semiconductor separated easily from a sapphire board. Furthermore, since Mohs hardness was about 9 and a very hard substance, it becomes easy to generate a crack and chipping in a cutting plane, and both sapphire and a nitriding thing semiconductor were not able to be correctly cut to it.

[0006]

[Problem to be solved by the invention] If a wafer can be correctly separated in the shape of a chip, without damaging the crystallinity of a nitriding thing semiconductor, chip form can be made small, and since many chips are obtained from one wafer, productivity can be raised. [ therefore, the place which this invention was made in view of such a situation, and is made into the purpose ] It faces separating the nitriding thing semiconductor wafer which uses sapphire as a substrate in the shape of a chip, the crack of a cutting plane and generating of chipping are prevented, the yield is good, and it is in offering the production method of the chip which obtains desired form and size.

[0007]

[Means for solving problem] The production method of the nitriding thing semiconductor chip of this invention is a thing under improvement of the method of manufacturing a nitriding thing semiconductor chip from the wafer which laminated the nitriding thing semiconductor on the sapphire board. [ a production method ] while the production method of this invention forms the first rate slot in a line in desired chip form from the gallium nitride system compound semiconductor layer side of a wafer [ in the process formed in the depth which penetrates a gallium nitride system compound semiconductor layer for this first rate slot, and excises a part of sapphire board, and the position which agrees with the line of the first rate slot from the sapphire board side of a wafer ] It is characterized by providing the process which forms the second rate slot which has line width (W2) thinner than the line width (W1) of the first rate slot, and the process which separates a wafer in the shape of a chip along the first rate slot and the second rate slot.

[0008] In the production method of this invention, in order to form the first rate slot, etching of wet etching, dry

etching, etc. is used most preferably. It is because etching does not damage the nitriding thing semiconductor surface and the side most easily. If it is dry etching, techniques, such as reactant ion etching, ion milling, converging beam etching, and ECR etching, can be used, for example, and if it is wet etching, the mixed acid of sulfuric acid and phosphorus acid can be used, for example. However, before etching, it cannot be overemphasized that the mask of predetermined form is formed in the nitriding thing semiconductor surface so that it may become desired chip form. Although the half cut by dicing besides etching, Sklar Eve, etc. may be used, dicing tends to damage the surface of a nitriding thing semiconductor, and the side physically, and Moreover, a sapphire board, Stress starts an interface with a nitriding thing semiconductor layer, and it is in the tendency for a nitriding thing semiconductor to separate easily from a sapphire board, and since it is difficult for Sklar Eve to form a rate slot larger than the second rate slot, she cannot say that it is not much desirable.

[0009] Next, in order to form the second rate slot in the sapphire board side, the technique of etching, dicing, Sklar Eve, etc. can be used. Since the second rate slot is formed in the sapphire board side and the edge of a blade, such as DAISA and a scriber, does not touch a direct nitriding thing semiconductor layer, at this process, the technique in particular of forming the second rate slot is not asked, but Sklar Eve is especially used preferably also in it. Because, Sklar Eve tends to make the line width of the second rate slot narrower than the line width of the first rate slot, and can form a rate slot quickly compared with etching. Furthermore, since there is little area which shaves off a sapphire board at the time of wafer cutting and it ends compared with dicing, there is an advantage that many chips are obtained from a single wafer.

[0010] Moreover, before forming the second rate slot, it is desirable to grind the sapphire board side and to make it thin. As for the thickness of the sapphire board after polish, adjusting to 150 micrometers or less is still more preferably desirable 200 micrometers or less. Because, the thickness of the nitriding thing semiconductor with which the thickness of the sapphire board was usually laminated 300-800 micrometers and on it is occupied with tens of [ at most ] micrometers, and, as for the nitriding thing semiconductor wafer, the most is occupied by the thickness of the sapphire board. And since the nitriding thing semiconductor is laminated on the material from which a grating constant and a coefficient of thermal expansion differ as described above, it has the character which is very hard to cut. If the thickness of a sapphire board is too thick, when forming the second rate slot behind and separating a wafer, it is in the tendency

which becomes difficult to break by the position which made the first rate slot and the second rate slot agree. That is, [ as shown in the dashed line of a of drawing 1 , it is most desirable that a wafer is separable in the shape of a chip in the position Chuo Line, the first rate groove line, and whose Chuo Line, the second rate groove line, corresponded, but ] When the thickness of a wafer is too thick, it becomes slanting and the position breaks, as similarly shown in the dashed line of c of drawing 1 , it is cut to a p-n junction interface, and is in the tendency whichis [ chip-] easy to beized in the target form. Therefore, a wafer can be made further easy to separate in the chip form made into the agreement position of said rate slot, i.e., the purpose, by grinding a sapphire board to said within the limits, and making it thin. Although the lower limit in particular of the thickness of a substrate does not ask, since the wafer itself will break easily during polish if it is made not much thin, as a practical value, 50 micrometers or more are desirable.

[0011] Moreover, as grind a substrate, and it is made thin and also it is shown in drawing 2 , by forming the second rate slot 22 in the sapphire board 1 deeply with techniques, such as etching and dicing, thickness of the sapphire board 1 may be partially made thin, and cutting distance with the first rate slot 11 may be shortened.

[0012]

[Function] An operation of the production method of this invention is explained based on Drawings. Drawing 1 or drawing 4 shows the process which cuts a wafer for a chip. However, drawing 3 shows the process which cuts out a wafer for a chip by the method of the work example of this invention. Drawing 1 is the ** type sectional view of the wafer which laminated n type nitriding thing semiconductor layer 2 (n type layer) and p type nitriding thing semiconductor layer 3 (p type layer) on the sapphire board 1. The state where formed the first rate slot 11 in the line, and the second rate slot 22 still narrower than the line width of the first rate slot 11 on the line width was formed in the position which is in agreement with Chuo Line, the line of the first rate slot 11, is shown so that it may become predetermined chip form at those nitriding thing semiconductor layer side. However, in this figure, the first rate slot etches p type layer 3, it forms it so that n type layer 2 may be exposed, and the second rate slot is formed by Sklar Eve. As it is most desirable that it can cut straightly at the point whose Chuo Line of the first rate slot 11 and the second rate slot 22 corresponded, i.e., the position shown with a dashed line a, as for a wafer as shown in drawing 1 , but a dashed line b shows, even if a line of cutting plane bends Since the line width W1 of the first rate slot 11 is

formed more widely than the line width W2 of the second rate slot 22, a cutting position does not attain to even a p-n junction interface, and a poor chip does not come out.

[0013] Drawing 2 forms the second rate slot 22 by etching or dicing, and shows the state where the half cut of the sapphire board 1 was carried out. In this figure, it can break by the position Chuo Line of the first rate slot and whose Chuo Line of the second rate slot corresponded straightly by making the depth of the second rate slot 22 deep, and shortening cutting distance with the first rate slot.

[0014] Although drawing 3 shows the method of the work example of this invention and shows the state where the etching depth of the first rate slot 11 was made deep, it can also cut this figure straightly in the position whose rate slot corresponded by shortening cutting distance of the first rate slot 11 and the second rate slot 22 as well as drawing 2 . thus, when forming a rate slot deeply and separating a chip It is desirable for the distance of the bottom of the rate slot 11 and a bottom with the rate slot 22 to be 200 micrometers or less, and to make thickness of the sapphire board 1 thin, and straight cutting can be carried out by making thickness of the sapphire board 1 thin partially in the position where both the rates slot agreed. In addition, also after grinding a sapphire board, before grinding (when grinding by a thickness of 200 micrometers or more), but it is difficult to form the rate slot 22 deeply to make the depth deep by Sklar Eve.

[0015] Thus, he shortens cutting distance and is trying to be straightly divided in drawing 3 by making deep the depth of the first rate slot 11, and the depth of the second rate slot 22. In addition, if a substrate is ground and it adjusts to 200 micrometers or less, it cannot be overemphasized that it is not necessary to make the depth of the second rate slot deep.

[0016] Drawing 4 is the top view which saw the wafer shown in drawing 1 from the nitriding thing semiconductor layer side, and while it shows the form of the first rate slot 11, it also shows chip form. In this figure, p type layer 3 is etched with the line width which the electrode of n layer can form beforehand, the first rate slot 11 is formed, it is considered as the form which cut and lacked the corner of p type layer 3 in the half-arc further, and the electrode of n layer can be formed in this portion cut and lacked.

[0017] Since the method of this invention makes the line width W1 of the first rate slot 11 larger than the line width W2 of the second rate slot 22 Even when a line of cutting plane becomes slanting temporarily and a wafer is cut, a cutting plane cannot enter to a p-n junction interface, a poor chip cannot come out, and many chips can be obtained from one wafer. And it is correctly separable in the cutting

position considered as a request by grinding the sapphire board of a wafer still more preferably, or making the depth of the second rate slot deep.

[0018]

[Working example]

[Comparative example 1] The wafer which laminated 5 micrometers and 1 micrometer of p type GaN layers for the n type GaN layer in order is prepared on the sapphire board of 400 micrometers in thickness, and size [ of 2 inches ] phi.

[0019] Next, on this p type GaN layer, after covering the mask which consists of SiO2 with photo lithography technology, etching is performed and the first rate slot is formed in the form shown in drawing 4 . However, the depth of the first rate slot shall be about 2 micrometers, and let it be the line width (W1) of 80 micrometers, and a 350-micrometer pitch. The line width of this first rate slot and a pitch are shown in drawing 4 .

[0020] After forming the first rate slot as mentioned above, the sapphire board side of a wafer is ground with a polish machine, a substrate is wrapped, and polishing is reached and carried out to a thickness of 80 micrometers. polishing -- the substrate surface -- a specular surface -- it supposes that it is uniform and carries out as [ check / easily / from a sapphire board side / the first rate slot ].

[0021] Next, pressure sensitive adhesive tape is stuck on the p type GaN layer side, a wafer is stuck on the table of a scriber, and it fixes by a vacuum chuck. A table is movable in the X-axis (right and left) and the direction of the Y-axis (before or after), and has structure which can be rotated. It acts in the direction of the X-axis as Sklar Eve of the sapphire board once by the diamond stylus of a scriber after fixation with a 350-micrometer pitch, a depth of 5 micrometers, and the line width of 5 micrometers. 90 degrees of tables are rotated and it acts as Sklar Eve like the direction of the Y-axis shortly. Thus, a SUKURA eve line is put in so that it may become the chip of a 350-micrometer angle, and the second rate slot is formed. However, let the position which forms the second rate slot be the position which was in agreement with Chuo Line, the line of said first rate slot.

[0022] Many chips of the 350-micrometer angle were obtained from the wafer of 2 inch phi by releasing a vacuum chuck after Sklar Eve, removing a wafer from a table, and pressing down with a roller lightly from the sapphire board side. When a crack, chipping, etc. did not occur in the cutting plane of the chip but the thing which has a poor outside and which is not was taken out, the yield was 98% or more.

[0023] [Comparative example 2] In the process which grinds the sapphire board of a comparative example 1, when

the thickness of the sapphire board was 150 micrometers and also the chip of the 350-micrometer angle was obtained similarly, the yield was 95% or more.

[0024] [Comparative example 3] In the process which grinds the sapphire board of a comparative example 1, when the thickness of the sapphire board was 200 micrometers and also the chip of the 350-micrometer angle was obtained similarly, the yield was 90% or more.

[0025] [Comparative example 4] In the process which forms the second rate slot of a comparative example 1, use DAISA instead of a scriber, and similarly carry out a half cut in a 350-micrometer pitch, and form the second rate slot, and also the line width of 20 micrometers and a depth of 10 micrometers make it the same. When the chip of the 350-micrometer angle was obtained, similarly the yield was 98% or more.

[0026] [Comparative example 5] In a comparative example 1, after forming the first rate slot, a wafer is set to DAISA, without grinding a sapphire board. When carried out dicing of the sapphire board side in the line width of 20 micrometers, and a depth of 300 micrometers, and the second rate slot was formed and also the chip of the 350-micrometer angle was obtained similarly, the yield was 95% or more.

[0027] As shown in drawing 1 or drawing 2 , as for the method of the above comparative examples 1-5, the first rate slot is prepared in the state where a gallium nitride system compound semiconductor layer is not penetrated. The production method of the gallium nitride system compound semiconductor chip of this invention penetrates a gallium nitride system compound semiconductor layer for the first rate slot, as shown in the sectional view of drawing 3 , and it forms it deeply by Fukashi who removes a part of sapphire board 1. Therefore, the method of this invention can cut a rate slot straightly in the congruous positions by shortening cutting distance of the first rate slot 11 and the second rate slot 22. The wafer which prepared the first rate slot and the second rate slot especially is separable into many chips by pressing down with a roller lightly from the sapphire board side.

[0028]

[Effect of the Invention] As explained above, according to the method of this invention, with techniques, such as Sklar Eve, DAISA, and laser, the nitriding thing semiconductor wafer which does not have ******** can also be correctly cut with the sufficient yield, and its productivity improves.

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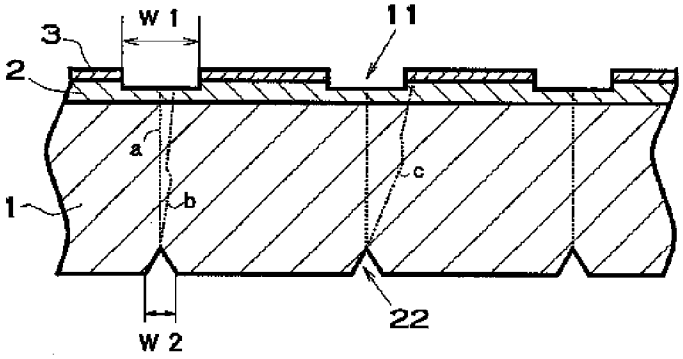
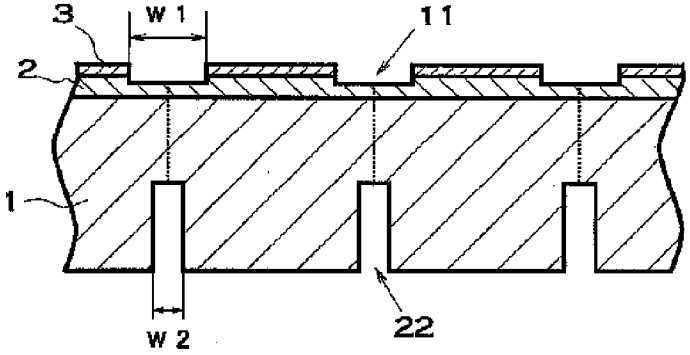
[Brief Description of the Drawings]

[Drawing 1] The ** type sectional view explaining the process which separates a wafer.
[Drawing 2] The ** type sectional view explaining the process which separates a wafer.
[Drawing 3] The ** type sectional view explaining the process which separates a wafer.
[Drawing 4] The top view explaining one process of the production method of this invention.
[Explanations of letters or numerals]
1 .... Sapphire board
2 .... n type layer
3 .... p type layer
11 ... Rate slot on the first
22 ... the -- the rate slot on two

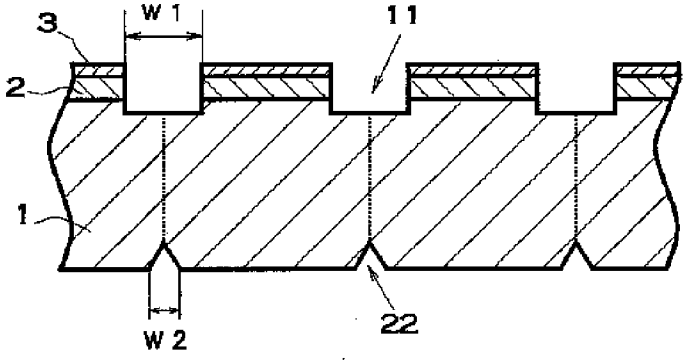
[Drawing 1]



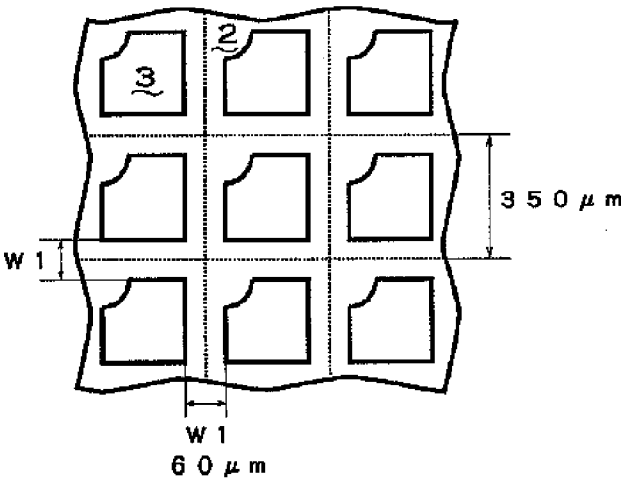

[Drawing 2]




[Drawing 3]



[Drawing 4]

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